Captain Michael G. Knollmann, USN and Commander Vincent A. Squitieri, USN

C4I Where the Rubber Meets the Road

Abstract

Carrier Battle Groups have always been utilized to project naval presence abroad as a means to carry out U.S. foreign policy. Recently, significant improvements in command, control, communications, computer, and information (C4I) systems have enabled increased efficiency and capability of the deployed battle group. Integrating these new capabilities and achieving their optimum performance remains a significant challenge to the operators and maintainers of these new and improved C4I systems.

The Constellation Battle Group (CONBATGRU) during 1999 completed a Western Pacific and Arabian Gulf deployment which included operations in both the Seventh and Fifth Fleet Areas of Responsibility. Coalition operations with the Korean and Japanese navies were conducted as well as operations in support of Operation Southern Watch in the Persian Gulf. This paper highlights CONBATGRU's experience with employing state of the art C4I systems to meet a dynamic set of operational requirements.

Specifically discussed are the growth in dependence on wide area and local area networks and their associated communications paths and the decline in the reliance on traditional record message systems. The operational data on the performance of these computer and data networks and associated communications paths is examined as well as a review of commercial practices with regard to network and communications support. The paper will address the implications of these operational C4I lessons learned for the future total ship design.

Introduction

A return to an earlier mode of fleet operations or a ground-breaking departure from typical overseas missions, CONSTELLATION Battle Group's 1999 deployment was a distinct change from the recent pattern of direct transits to the Arabian Gulf. This deployment started with a transit to northeast Asia, included operations with battle group units spread over a large area of the Eastern hemisphere, and reached a climax with unusually active Maritime Intercept Operations (MIO) in the Northern Arabian Gulf (NAG) and air combat missions in support of Operation SOUTHERN WATCH (OSW) over southern Iraq. In executing these missions, the CONNIE Battle Group straddled the limitations of today's C4I suites and the potential for tomorrow's network centric warfare. The experience yielded insights into technical limits on fleet operations and of operational limits on technology that must be remedied before can deliver the full advantage of battlefield knowledge domination. This paper offers C4I lessons learned from our recent deployment and the implications for the total ship design. Before discussing the perspectives on the technical aspects of the CONNIE Battle Group's

experiences, it would be useful to outline the operational context of our deployment and offer thoughts on the operational employment of C4I capabilities from a battle group operations perspective.

Deployment Overview

Shortly before the scheduled date of deployment for the CONSTELLATION Battle Group, stability in northeast Asia was threatened by a series of clashes between naval forces and fishing vessels off the west coast of Korea. Sortie of the Forward Deployed Naval Forces - typically the KITTYHAWK Battle Group homeported in Japan - usually provides the stabilizing naval influence in the region. At this juncture, KITTYHAWK was not available to serve as the cop on the beat. The carrier and supporting battle group elements was deployed even further forward providing the naval presence in the Arabian Gulf.

With the CONSTELLATION Battle Group (CONBATGRU) nearing readiness for deployment, the decision was made to bring the force to the waters near off Korea and Japan. In advance of the main battle group's departure, the Air Wing's squadron of EA-6B Prowlers flew ahead to take station in Japan. The aircraft carrier and surface escorts proceeded to Hawaii for final work-ups, and steamed at high speed to the Sea of Japan.

The detour to northeast Asian waters afforded opportunities to conduct bilateral exercises with the Republic of Korea Navy (ROKN) and with the U.S. Air Force stationed ashore on the Korean Peninsula. Ships also enjoyed the opportunity to make port calls in Pusan and Chinhae. The proximity to Japan also presented opportunities for bilateral exercises with the Japanese Maritime Self Defense Force (JMSDF). Divergent tasks drew battle group ships to disperse. A cruiser sped to Inchon, Korea, to host the visiting Secretary of Defense. Two destroyers detached from the main body to proceed ahead to the Arabian Gulf. Port calls to Yokosuka and Sasebo rounded out northern operations for the rest of the task group.

Evasion of a major hurricane veering northwest between Taiwan and Korea added urgency to the battlegroup transit to the South China Sea. Passing the homeward-bound KITTYHAWK Battle Group near the entrance to the Strait of Malacca, CONBATGRU entered Singapore for recreation and minor voyage repairs. After a brief period of pilot proficiency training, CONNIE transited through the Strait of Malacca for a stop in Malaysia's Port Kelang and the nearby metropolis of Kuala Lumpur.

From Malaysia, CONNIE and consorts sailed directly to the Arabian Gulf and operations with the U.S. FIFTH Fleet. The situation in the Arabian Gulf was dominated by three areas of operations: enforcement of the No-Fly Zone over southern Iraq; enforcement of UN Sanctions controlling imports and exports with Iraq, and regional engagement including bilateral and multilateral exercises. Operations over Iraq are in the nature of air combat with significant anti-air ordnance continuing to be employed by Iraq and with bombing missions responding to Iraqi provocations. Afloat, a resurgence of smuggling efforts accrued from the rising price of oil products. Interdiction

operations accelerated apace. Aggressive enforcement of trade sanctions engaged CONBATGRU with the active assistance of maritime forces from Kuwait, the United Kingdom and New Zealand. Regional engagement included a range of missions from major international maritime exercises to development of personal affiliations through VIP visits aboard battle group ships inport and underway.

CONBATGRU rounded out the deployment with exceptional "Quality of Life" port visits. A northern task unit of two ships visited Thailand and Hong Kong. CONSTELLATION led the main body to welcome port calls in Australia. Again, business mixed with recreation as CONBATGRU ships conducted bilateral exercises with Australian forces during their transits "Down Under".

Battle Group Composition: A Joint and Combined Naval Force

CONSTELLATION Battle Group included a range of combatant capabilities that are typical of America's deploying naval forces. Embarked in the centerpiece aircraft carrier CONSTELLATION was an Air Wing with F/A-18 squadrons, an F-14D squadron, an EA-6B squadron, an S-3B squadron, a helicopter squadron with HH-60H and SH-60B aircraft, and C-2 logistics aircraft detachment. CONNIE also served as flagship for Commander, Cruiser-Destroyer Group ONE and for Commander, Destroyer Squadron SEVEN. Two cruisers, two destroyers, two submarines and a fast fleet logistics ship completed the U.S. Navy contingent of the battle group.

The task group deviated from normal composition by the addition of a Canadian frigate and a U.S. Coast Guard high endurance cutter as integrated elements. Subordinated to Commander, CONBATGRU, these two ships expanded the force capabilities, while posing some technical and operational challenges to connectivity.

Nature of C4I Challenges

Internally and externally, the battle group was expected to interact seamlessly with national and international forces spread across half of the world. Working across the Areas of Responsibility (AORs) of three fleet commanders, with four different United States military services and with the military forces of sixteen different countries, CONNIE Battle Group experienced a wide range of C4I interoperability.

There were no startling C4I lessons learned. Connectivity remained the challenge of cataloging capabilities of units to be connected and looking for common ground. At one end of the spectrum are signal flags, tactical maneuvering signals and bridge-to-bridge/line-of-sight voice communications. At the other end is global secure E-mail graphics exchange, tele-video conferencing and full-spectrum Link 16 tactical data transfer. Connectivity was rarely a go/no-go proposition. If one technology did not provide an interface, there always seemed to be another option available, although at some trade-off in data throughput and timeliness of delivery.

In retrospect, there were a number of factors obstructing seamless

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interoperability. Obstacles to C4I connectivity fell into one or more of the following categories:

- Mismatched technologies
- Organization, training, and maintenance.
- Operational procedures and constraints.
- Physical limitations.
- Intentional Countermeasures.

Mismatched technologies. The matching of C4I technologies within a battle group is a major pre-deployment effort. CONSTELLATION embarked on the 1999 deployment with thirty-nine years of incremental C4I improvements. The aircraft carrier's C4I suite provides remarkably robust capabilities given the "add a little, take a little" approach to electronics equipment installations. As the capital ship crosses the five-year threshold before projected retirement, each equipment update or addition is weighed on a "cost-benefit" basis. For example, the embarked staffs and ship's company share a SIPRNET (a secure Internet-like information network) "Warfighter network" system installation representing an automated data processing capability which approximates the capabilities of a fully compliant IT-21 suite. In an era of restrictive budgets, this approach makes fiscal sense, but CONNIE, and the battle group formed around CONNIE, might find itself on the trailing edge of C4I as the fleet accelerates progress to wide area network integration.

In contrast, CONNIE'S embarked Air Wing employed the very latest modifications to combat aircraft. Aircraft flying from CONNIE's deck constituted the most potent and modern naval air force in the world.

In the rest of the battle group, variation in C4I capabilities also proved distinctive. Two AEGIS cruisers, an ARLEIGH BURKE Class destroyer, a SPRUANCE Class destroyer, two LOS ANGELES Class submarines, a Canadian frigate, and a Coast Guard high endurance cutter brought a mixed bag of C4I equipment to the deployment. None of the surface or subsurface escort units had full-time/real-time secure network capabilities. Through a combination of equipment limitations, satellite access limitations and funding limitations, these ships were not capable of such activities as "web surfing". Link 11 and Global Command and Control System - Maritime (GCCS-M) OPNOTES were the highest common denominators for real-time data exchange and messaging. Only CONSTELLATION was capable of Video Tele-Conferencing. The Navy is moving from a "record traffic" world that pushes information to an email and network query world requiring the pulling of information by web surfing. The mismatch of capabilities between a Navy speeding to network centric warfare and CONNIE Battle Group capabilities represented a significant obstruction to C4I connectivity.

Organization, training, and maintenance. Any new technology takes "soak in" time to reach its potential in the fleet. Organizations must integrate the technology into the overall scheme of connectivity. Operating personnel must learn when - and when not - to employ the new technology. Maintainers must learn repair procedures and be outfitted with

appropriate spare parts. The Navy recognizes this delay between technical installations and achievement of actual capabilities with a policy that terminates new equipment installations several months before deployment. Incremental improvements after the Technical Cutoff Date require deliberate agreement from technical authorities ashore and senior decision-makers afloat, but risk deployment without a fully functional capability.

Battle Force E-Mail was a case in point. Installed late in the inter-deployment cycle, battle force e-mail was intended to provide a secure HF interface between CONNIE and escorts for the forwarding of email. Unfortunately, the capability had not matured as the battle group deployed. Inadequate training and experience with the system prevented activation of BF E-Mail throughout most of the transit to the Arabian Gulf. Two senior Information Technicians from the battle force logistics ship took the initiative to travel from ship to ship configuring BF E-Mail software, aligning communication interfaces and conducting technician training. While their efforts yielded a technically functional E-Mail capability, there was little time to put corresponding operational procedures into effect to derive the maximum of benefit from the system.

Operational constraints. Navy-wide OPTASKS encourage standardization of world-wide operational procedures, but each theater retains distinctive variations. These variations reflect differences in the capabilities of regional allies and potential opponents, as well as the differences in missions and assigned units. In some cases, political-military considerations influence the nature of authorized C4I operations. In the context of an emerging network-centric tactical architecture, system-high classification imposes restrictions on allied access to critical American command and control conduits. Until multi-level security access is perfected and certified, operational security will require provisions for parallel command and control connectivity with allies.

One aspect of operational constraints is beginning to exert a significant impact on C4I capabilities. International conventions and usage restricting sizable portions of the Electromagnetic spectrum place significant constraints on employment of electronic equipment in proximity to land. Battle group missions frequently require operations in the vicinity of allied and neutral countries. Spectrum use restrictions cannot be dismissed as issues of little consequence during hostilities. C4I capabilities requiring broad spectrum emissions are likely to be limited in use during critical operations.

Physical limitations. Radar and radio wave propagation remain subject to environmental influences. Meteorological support can predict anomalies such as ducting, precipitation, and sunspot interference, but the resulting effects still disrupt C4I connectivity. C4I installation design can aggravate susceptibility to physical effects. For example, several ships in CONBATGRU received INMARSAT B transceiver systems to improve E-Mail throughput with servers ashore. The single antenna provided was subject to hull masking as ships maneuvered and severe signal attenuation from ship's motion in moderate seas.

Intentional Countermeasures.
Jamming and intrusion pose significant threats to C4I connectivity. These countermeasures can be as low-tech as playing music over bridge-to-bridge radio circuits or as sophisticated as hacker attacks on tactical wide area networks. The Navy recognizes the threat from intentional C4I attacks, and implements a variety of counter-counter measures.

A Closer Look

The following provides a deeper look at the elements of C4I experienced by CONSTELLATION Battle Group during WESTAC/Arabian Gulf 99. These experiences convey an operational perspective on technology in the forefront of operational employment – where the rubber meets the road.

Prior to the 1999 deployment, CONSTELLATION Battle Group was equipped with a robust C4I capability which included for the carrier an extensive 160 workstation classified local area network referred to as the "Warfighter Network", an 800 workstation unclassified local area network as well as external connectivity via Challenge Athena commercial satellite system and Super High Frequency (SHF) commercial satellite system. Surface combatants were outfitted with a range of local area networks and for external connectivity most ships had Extremely High Frequency Network Communications Controller (EHF NECC), the Aegis Cruisers had INMARSAT B High Speed Data, and the remaining surface combatants had a dial up email capability via INMARSAT B. While the resulting C4I architecture was superb, individual system reliability was inconsistent, and challenged even the most capable fleet operators and maintainers.

First, it must be recognized that reliable siprnet and niprnet connectivity is an indispensable element of effective battle group operations. Critical tactical and administrative information is now available from regional web sites. Message exchange via siprnet and niprnet has replaced Autodin Record Message traffic. CONSTELLATION averaged less than 100 outgoing Autodin messages per day. In comparison, CONSTELLATION averaged 9550 incoming and 8760 outgoing niprnet daily. On the siprnet network, CONSTELLATION averaged 800 incoming messages and 713 outgoing messages daily. Clearly official business is now being conducted via email. All battle group ships must possess a high speed data exchange capability to function effectively in this environment. Lack of a high speed data pipe impedes full participation in tactical decisions by off ship subordinate commanders. These data networks are not considered mission critical systems since they do not put weapons on target. However, they are a critical warfare support system which must be maintained reliably during battle group operations.

As noted previously, CONSTELLATION Battle Group experienced inconsistent system performance reliability throughout the deployment. Significant delays in waiting for external technical assist kept critical systems off line for extended periods of time. It is clear that we need to address the manner in which we

support our C4I systems for future C4I system procurements. Table 1 is a compendium of CONSTELLATION Battle Group C4I casualty reports requiring outside technical assist that occurred during the deployment.

Comm Systems	Days Awaiting Assist	Days of Tech Assist
CV SAT LINK	12	3
CV EHF NECC	11	1
. CG EHF SAT	10	6
DDG EHF NECC	26	9
CG INM B HSD	16	8
. CG INM B HSD	17	3
CG INM B HSD	30	4
. CG INM B HSD	3	1
DD INM A	2	4
DD INM A	4	9
Network Systems		
CV Class Network	17	14
DDG Classified Network	7	10
DD Classified Network	13	4
. DD Classified Network	13	14
Command and Control Systems		
CV GCCS-M Sys	3	10
. CV CTAPS	0	24
CG GCCS-M	13	4
DDG GCCS-M	19	12

Table 1

Analysis of this data reveals that 73 percent of outage time for communications casualties, 54 percent of outage time for network casualties, and 41 percent of outage time for command and control casualties was spent awaiting technical assist. The majority of this time was expended on phone conversations between shore support personnel and shipboard technicians ascertaining the nature of the technical problem to ensure that the proper technical support was provided.

Of particular note was the Contingency Theater Air Planning System (CTAPS) casualty on the carrier which experienced no delay in technical assist. This casualty occurred early in the deployment when a systems command technical representative was embarked with the Battle Group and troubleshooting efforts could begin immediately.

Life Cycle Management.

The pace of advances in commercial communications and networking technologies dictate that the life cycle of new products are fielded in very short periods of time. The Navy's training infrastructure and ability to develop formal C4I training pipelines for our sailors cannot keep pace with these advances. Commercial industry has recognized this and opted to outsource and contract out for information technology services. The Navy must also complement the existing training we give our sailors with civilian technicians to augment a deployed Battle Group staff. Our C4I systems have become critical to the successful operations of the Battle Group. The high tempo of operations dictate that we keep our C4I system outages to a minimum and the delays experienced awaiting tech assist must be curtailed. The data presented supports the establishment of an onboard technical support team with expertise in the command and control, satellite communications, and network systems administration areas. This support is required to the Battle Group from the beginning of work ups through at least two thirds of the deployment, departing after significant operations are completed. This group would provide the continuity required to keep track of system configuration management changes, and minimize the time expended by technicians ascertaining the system configuration and the nature of the system outage.

This level of support is not unprecedented. During the Vietnam War many civilian contractors worked alongside our sailors ensuring that all shipboard systems were maintained in the highest state of combat readiness. More recently, when a new airframe is introduced to the fleet, it is not unusual to find a complement of civilian technicians assigned to deploy with the Battle Group to support operations of the new airframe.

The technical design of our communication and computer networks must also be reviewed. Commercial network products which enable the automatic distribution of software upgrades and can also automatically conduct software configuration audits of the network must be employed. This would address an existing significant fleet problem with network configuration management. One of the leading causes of network casualties is the inability to maintain effective and proper configuration of the network. This causes system administrators to be at a significant disadvantage when attempting to troubleshoot the network.

Further review of the operational performance of the INMARSAT B HSD systems aboard the two cruisers within the Battle Group revealed that significant thought must be given to the topside design of surface combatants. Both USS CHOSIN and USS LAKE ERIE were outfitted with a single antenna INMARSAT B HSD system. Both ships experienced sporadic system performance due to significant superstructure blockages. Successful system operations required maintaining an INMARSAT B HSD course in order to maintain linkage with the satellite. This unreliable system performance drives a requirement for dual antenna INMARSAT B HSD for all surface combatants. As we embark upon Super High Frequency (SHF) installation in cruisers, the dual antenna requirement is critical to ensure continuous satellite

connectivity. With the proliferation of shipboard satellite systems, such as SHF, INMARSAT B HSD, and Television Direct to Sailor (TV-DTS), the future ship design must take precious topside real estate into careful consideration when determining how these satellite systems will be fielded.

Implications for Total Ship Design

Every deployment is different; every deployment teaches new lessons, especially in the area of C4I. As a case in point, the latest deployment of the CONSTELLATION Battle Group is a reminder that technical advances do not exist in a perfect world.

New ships must incorporate a wide range of C4I capabilities. C4I suites incorporated into new ship designs should provide backwards compatibility. The reality of fiscal constraints prevents the fleet and forces ashore from making simultaneous leaps to new technologies. In general, allied navies will lag U.S. forces in acquiring new technologies, or will pursue alternate technical solutions. It will be incumbent on new ships to interact efficiently on several levels of technical sophistication to achieve C4I connectivity.

New ship designs must employ technology that is operationally relevant and manpower efficient.

This is not a truism related to mandated crew reductions. New C4I technologies should be operationally relevant, that is, the technologies must provide a decisive return on installation and operation expenses. Soon after deployment, a telling picture appeared on a battle staff bulletin board. It depicted the actor George C. Scott posing in front of an American flag in his role as General George S. Patton. The caption parodied General Patton's "blood 'n guts" style of oration with the words,

> "No one ever won a war by making PowerPoint slides. You win the war by making the other poor bastard make PowerPoint slides!"

PowerPoint slide production can absorb many hours of staff officer labor without appreciably improving tactical knowledge or decisions. To some extent, Global Command and Control System - Maritime (GCCS-M) suffers the same profit-loss balance. With large expenditures of manpower for plot resolution and fusion, the resultant tactical information is frequently less timely and less accurate than Link 11 data available for direct (if monochrome) display.

New C4I technologies should be operationally transparent. Tactical operators do not care if a radio-telephone connection is completed by UHF, SHF or EHF satellite pathways any more than a civilian technology user cares about the path taken by E-mail. Tactical operators likewise rarely care how communications officers allocate bandwidth between competing requirements as long as imagery transfers, tele-video conferences, web surfing, E-mail and long-haul telephone services do not suffer degradations. Future users expect seamless, uninterrupted data exchange services. A variety of input/output media and sophisticated multiplexing will be required for external interfaces. Internally, standardized plug-and-play workstations and wireless connections could replace dedicated command and

control workspaces and militarized consoles.

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To all the members of the CONBATGRU, their perseverance and dedication led to a superb and highly successful deployment. The lessons learned will serve all future deploying battle groups and the U.S. Navy for years to come.

Captain Michael G. Knollmann was born in Cincinnati, Ohio. He enlisted in the Navy in January, 1973 and received his commission in the Supply Corps via Officer Candidate School in May, 1978. He joined the commissioning staff of Commander, Destroyer Squadron THIRTY-TWO prior to attending Surface Warfare Officer School (SWOS) Division Officer Course. He reported aboard USS CONOLLY (DD 979) and served in several division officer billets. He reported to the Pentagon on the OPNAV Staff as a program analyst and aide to the Vice Chief of Naval Operations. He returned to sea duty for department head assignments in USS STARK (FFG 31) and on the staff of Commander, Destroyer Squadron TWENTY-FOUR. Capt Knollmann graduated from the senior joint professional curriculum at the Armed Forces Staff College, and served as a NATO staff officer at Supreme Headquarters Allied Powers Europe (SHAPE) in Casteau, Belgium. He rejoined the fleet as executive officer of USS SPRUANCE (DD 963) and subsequently USS BOONE (FFG 28). In 1993, Capt Knollmann returned to Washington for duty with the Operations

Directorate of the Joint Staff. In 1996, he assumed duties as Commanding Officer of USS DECATUR when the ship entered commissioned service in August, 1998. In June 1999, he reported for duty as Assistant Chief of Staff, Operations and Plans, on the staff of Commander, Cruiser Destroyer Group One. His technical expertise includes air, surface and subsurface battle group operations, Aegis combat and air defense systems, shipboard computer and data networks, and shipboard satellite communications.

Commander Vincent A. Squitieri graduated in 1980 with a BS in mechanical engineering from the Massachusetts Institute of Technology, Cambridge, Massachusetts. He received a master's degree from the Naval Postgraduate School, Monterey, California in 1988 in electrical engineering. He also graduated from the Advanced Program Manager's Course at the Defense Systems Management College, Alexandria, Virginia in 1996.

Commander Squitieri's Surface Warfare tours include Electronics Material Officer and Electrical Division Officer aboard USS Connole (FF 1056), Main Propulsion Assistant aboard USS Semmes (DDG 18), Engineer Officer aboard USS Buchanan (DDG 18), and Executive Officer aboard USS Robert G. Bradley (FFG 49). From 1991-1994 he served as project manager in the Space and Naval Warfare Systems Command Computer Architectures Directorate responsible for reviewing commercial computer interface standards for applicability in naval warfare support systems. From 1995-1998 he served as assistant program manager in the Space and Naval Warfare Systems Command Global Command and Control System

Maritime Program Office. He was responsible for system integration and fielding of afloat Navy command and control systems and later served as resources division head responsible for life cycle support of Navy command and control systems.

Commander Squitieri is currently assigned to Commander, Cruiser Destroyer group One as Assistant Chief of Staff for Command, Control, Communications, computer, and Information Systems. His technical expertise includes shipboard electrical and main propulsion systems, electronics and radar systems, integrated computer and data networks, satellite and line of sight communications systems, and command and control systems.

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The writer will focus on fleet operational C4I requirements and describe the growth in dependence on wide area networks and associated communications paths and the decline in the reliance on traditional message paths, such as CUDIX, NOVA, and NAVCOMPARS. The paper will draw upon Constellation Battle Group's recently completed 1999 Western Pacific and Arabian Gulf deployment and describe the Battle Group C4I architecture and associated challenges maintaining and operating the suite of C4I systems throughout the Battle Group. The deployment included operations in both the Seventh and Fifth Fleet Areas of Responsibility including coalition operations with the Korean and Japanese Navies as well as operations in support of Operation Southern Watch in the Persian Gulf. The paper will provide operational data on the performance of computer and data networks as well as the associated communications paths and discuss the manner in which the Navy provides support to these networks and communications pathways. The paper will review commercial practices with regard to network and communications support and make recommendations on how the Navy can best provide C4I logistics and technical support both in computer network design and in the accompanying supportability strategy. The paper will address what the implications of these operational C4I lessons learned are for the total ship design.

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